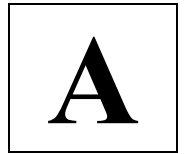


**Exam 4**

Recitation Section (see back of test): \_\_\_\_\_

- 1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".
- 2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.
- 3) For each free-response question, show all relevant work supporting your answer. **Clearly box or underline your final answer.** "Correct" answers which are not supported by adequate calculations and/or reasoning will be counted wrong.
- 4) For each multiple-choice question, select the answer most nearly correct, **circle this answer on your test**, and bubble it in on your answer card. **Show all relevant work on your quiz.**
- 5) Be prepared to present your Buzzcard as you turn in your test. Scores will be posted to WebAssign after they have been graded. **Quiz grades become final when the next quiz is given.**
- 6) You may use a simple scientific calculator capable of logarithms, exponentials, and trigonometric functions. **Programmable engineering calculators with text or graphical capabilities are not allowed. Wireless devices are prohibited.**



Your test form is: **642**

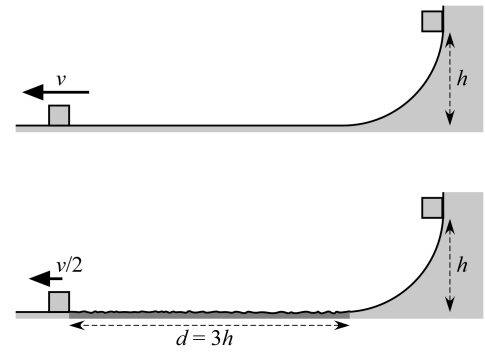
The image shows a Scantron answer card for a test form numbered 642. The student's name, "George P. Burdell", is handwritten in the "STUDENT IDENTIFICATION" section. The student number "123 900987654" is also handwritten. The card features a grid of bubbles for marking answers, with columns numbered 1 through 50. A box highlights the first four columns, with an arrow pointing to the first column and the text "Your answers". Several text boxes provide instructions: "WRITTEN information for human benefit", "Test Form Number from YOUR test column 4 is blank", and "YOUR student number starts in column 5". The card includes the Scantron logo and copyright information: "© SCANTRON CORPORATION 2002 To Register 1-800-722-8876 P2206 999-10".

**Our Final Exam will be held on Monday, December 7 at 8:00am!**

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

- [I]** (20 points) A block is released from rest on a ramp of height  $h$ . It slides without friction to the bottom of the ramp, and then continues across a horizontal frictionless surface, with a final speed  $v$ . A second identical block is released from the same height on a similar ramp. When it reaches the bottom of the ramp, it crosses a rough horizontal patch having length  $d = 3h$ . When it leaves the rough patch, it has a speed  $v/2$ .

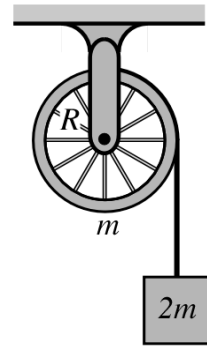
Use the General Work-Energy Principle to find the coefficient of friction of the rough patch.



The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

- [II]** (20 points) A string is wrapped around a pulley wheel of mass  $m$  and radius  $R$ , as shown in the figure. The pulley can rotate freely about its axle, without any friction. The loose end of the string is attached to a block of mass  $2m$ . You may assume that the spokes of the pulley wheel have negligible mass, so that it may be treated as an ideal hoop, with  $I_{\text{cm}} = mR^2$ .

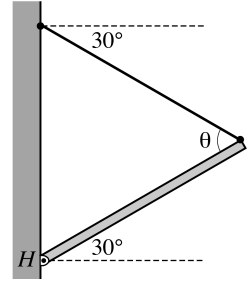
Find an expression for the tension in the cord when the block is released. Express your answer as a multiple of  $mg$ .



The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

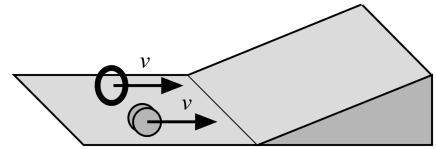
- [III]** (20 points) A hinged beam of weight  $W$  is attached to a vertical wall, supported in equilibrium by a cable that is attached to the wall above the hinge point. The beam is oriented at a  $30^\circ$  angle *above* the horizontal, while the cable is directed at an angle of  $30^\circ$  *below* the horizontal. Determine the Tension  $T$  in the cord, as well as the magnitude and direction of the force  $\vec{H}$  exerted by the hinge on the beam.

Express both force magnitudes as multiples of the beam's weight  $W$ . Express the direction of  $\vec{H}$  as an angle  $\phi$  relative to the horizontal



*Question value 5 points*

- (1) A hoop ( $I_{\text{cm}} = mr^2$ ) and a uniform disk ( $I_{\text{cm}} = \frac{1}{2}MR^2$ ) are both rolling without slipping along a horizontal surface, when they encounter an upward ramp. Which of the two objects will roll to the highest point on the ramp, before stopping?



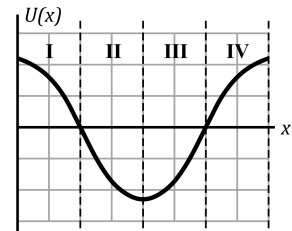
- (c) The object with the greater radius will roll the highest.  
 (b) The disk will roll the highest, regardless of mass or radius.  
 (c) The object with the greater mass will roll the highest.  
 (d) The hoop will roll highest, regardless of mass or radius.  
 (e) They will roll to the same height, regardless of mass or radius.

*Question value 5 points*

- (2) A conservative force, acting alone, does *negative* work on an object. As a result of this work,
- (a) ...the potential energy *decreases* and the total mechanical energy *increases*.  
 (b) ...the potential energy *increases* and the total mechanical energy *decreases*.  
 (c) ...the potential energy *increases* and the total mechanical energy *does not change*.  
 (d) ...the potential energy *does not change* and the total mechanical energy *decreases*.  
 (e) ...the potential energy *decreases* and the total mechanical energy *does not change*.

*Question value 5 points*

- (3) The graphs at right displays the potential energy curve for a conservative force that acts on a particle that is otherwise free to move along the  $x$ -axis. In which of the regions shown is the particle experiencing a force in the negative  $x$ -direction?



- (a) In regions II and III.  
 (b) In regions I and IV.  
 (c) In regions III and IV.  
 (d) In none of the regions shown.  
 (e) In regions I and II.

The next two questions involve the following situation:

A non-uniform rod of mass  $M$  and length  $L$  lies along the  $x$ -axis, extending from  $x = 0$  to  $x = L$ . The rod is characterized by a linear mass density that satisfies the expression:

$$\lambda(x) = \frac{2M}{3L} \left(1 + \frac{x}{L}\right) \quad \text{for } 0 \leq x \leq L$$

*Question value 5 points*

- (4) What is the  $x$ -coordinate of the rod's center of mass?

- (a)  $x_{\text{cm}} = \frac{1}{2}L$
- (b)  $x_{\text{cm}} = \frac{2}{3}L$
- (c)  $x_{\text{cm}} = \frac{4}{9}L$
- (d)  $x_{\text{cm}} = \frac{3}{5}L$
- (e)  $x_{\text{cm}} = \frac{5}{9}L$

*Question value 5 points*

- (5) Lamar, Chloe, and Ralph each have identical copies of the rod described above. Lamar sets a perpendicular pivot axis through the rod at the left end ( $x = 0$ ). Chloe sets a perpendicular pivot axis through the center of mass. Ralph sets a perpendicular pivot axis through the right end of the rod. Starting from rest, all three rods are then spun up to the same final angular speed,  $\omega$ . Rank, from greatest to least the work that is required to cause each of these rotations.

- (a)  $W_L > W_R > W_C$
- (b)  $W_C > W_R > W_L$
- (c)  $W_L = W_R = W_C$
- (d)  $W_R > W_L > W_C$
- (e)  $W_C > W_L = W_R$

The next two questions involve the following situation:

Object A has mass  $m$  and object B has mass  $2m$ . Starting from rest, both objects are pushed in a straight line along a frictionless surface by force of magnitude  $F$ .

*Question value 5 points*

- (6) Suppose that both objects are pushed through the same total distance  $D$  by the force. Compare the work done on objects A and B by force  $F$ , and also compare the (magnitude of) impulse delivered to objects A and B by force  $F$ .
- (a)  $W_B > W_A$  and  $J_B = J_A$
  - (b)  $W_B < W_A$  and  $J_B > J_A$
  - (c)  $W_B = W_A$  and  $J_B = J_A$
  - (d)  $W_B > W_A$  and  $J_B < J_A$
  - (e)  $W_B = W_A$  and  $J_B > J_A$

*Question value 5 points*

- (7) Suppose instead that both objects are pushed for the same total time  $\Delta t$  by the force. Compare the work done on objects A and B by force  $F$ , and also compare the (magnitude of) impulse delivered to objects A and B by force  $F$ .
- (a)  $W_B = W_A$  and  $J_B = J_A$
  - (b)  $W_B > W_A$  and  $J_B > J_A$
  - (c)  $W_B = W_A$  and  $J_B < J_A$
  - (d)  $W_B < W_A$  and  $J_B = J_A$
  - (e)  $W_B < W_A$  and  $J_B > J_A$

*Question value 5 points*

- (8) A baseball is thrown straight upward with a large initial speed  $v$ . The instantaneous power delivered to the baseball by gravity, as the ball rises to its highest point, is:
- (a) constant and *positive* throughout the ball's rise.
  - (b) *negative* throughout the ball's rise, initially very large but gradually dropping to zero.
  - (c) initially *zero*, but gradually increasing to a large *negative* value as the ball rises.
  - (d) always *zero*, because no power is ever delivered by a conservative force like gravity.
  - (e) constant and *negative* throughout the ball's rise

## PHYS 2211 A/B Recitation TA and Room Assignments

Tests will be returned in recitation, ideally in the *same* week as the test is given. In order to ensure that you receive your test back as soon as possible, please enter your recitation section from the table above on the front of this test.

	Clough 123	Clough 125	Clough 127	Clough 131
<b>WEDNESDAY</b>				
1:05 – 1:55 pm	B01 Dark, Jason			
2:05 – 2:55 pm		A01 Coenen, Ashley		
3:05 – 3:55 pm			B06 Coenen, Ashley	A05 Cowan, Erika
4:05 – 4:55 pm	B05 Eswar, Aditya	B02 Dark, Jason	A02 Coenen, Ashley	A06 Cowan, Erika
<b>THURSDAY</b>				
1:05 – 1:55 pm				
2:05 – 2:55 pm	A03 Eswar, Aditya	B08 Cowan, Erika	B03 Dark, Jason	
3:05 – 3:55 pm			A07/B07 Dark, Jason	
4:05 – 4:55 pm	A04 Eswar, Aditya		B04 Dark, Jason	
5:05 – 5:55 pm			A08 Dark, Jason	